PHYSICS

BOOKS - BHARATI BHAWAN PHYSICS (HINGLISH)

WAVE MOTION

Examples

1. Show that the equation $y = a\sin(pt - kx)$ represents a progressive wave. Calculate the

velocity of the wave.

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2. In Quincke's experiment on interference of sound a turning fork of frequency $540Hz$ is used. Calculate the distance by which the sliding tube is to be drawn out to pass from one minimum to the next minimum.

(Velocity of sound $= 350ms^{-1}$)

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3. Calculate the velocity of sound in a gas in which two waves of wavelength 1 m and $1.01m$ produce 20 beats in 6 seconds.

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4. Two turning forks make 4 beats per second when sounded together. One fork makes 256 vibrations per second and the betas case when the other fork is loaded with a small piece of wax. What is the frequency of the second fork?

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5. Fifty-one turning forks are arranged in order of increasing frequencies so that each fork gives 3 beats per second with the next. The last fork gives the fifth of the first. Calculate the frequency of the latter.

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6. A wave of frequency $300Hz$ has a phase velocity of $350ms^{-1}$. (a) How far apart are two points $\pi/6$ out of phase? (b) What is the phase difference between two displacements at a certain point at times $10^{-2}s$ apart?

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7. An echo repeats four syllables. Find the distance of the reflecting surface, if it takes one-fifth of a second to pronounce or hear

one syllable distinctly. (Velocity of sound $= 340m/s$).

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8. Two identical loudspenkers are placed on a line at distances $4m$ and $5.1875m$ from a microphone lying on the same line. If the output of each speaker at the microphone be $2mW$, find the resultant output at the microphone, if the two speakers are connected in series and excited by the same oscillator.

What is the output at the place if they are excited by separate indentical oscillators of the same freequency? Velocity of sound $= 350ms^{-1}$ and frequency of oscillators $= 700Hz.$

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9. Two plane longitudinal waves propagate along the x-axis and y-axis: $\zeta_1 = a\cos(wt - kx)$ and $\zeta_2 = a\cos(wt - ky($

. Find the wave pattern of the particles in the xy plane.

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Exercises

1. A plane progressive wave is $y = 0.02 \sin(400t - 0.12x)$. Calculate the following:

(i) amplitude of wave, (ii) frequency of wave, (iii) wavelength of wave, (iv) interval at which a

compression follows a rerefaction, (v) velocity of the wave.

[Hint: compare this equation with the standard $y = a\sin(2\pi nt - 2\pi x/\lambda)$]

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2. Show that the equation $y = a\sin\left(2\pi nt - \frac{2\pi}{\lambda}x\right)$ respresents a progressive wave of velocity C given by $C = n\lambda$.

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3. Write down the equation of a wave travelling in the negative direaction along x-axis with an amplitude $0.01m$, a frequency $550Hz$ and a speed $330m/s$.

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4. Sixty-four tuning forks are arranged in order of increasing frequency and any two successive forks give four beats per second when sounded together. If the last fork gives

the occtave of the first, calculate the frequency of the latter

[Hint: When two frequencies are such that one is double the other, the higher one is said to be an actave higher than the first and the lower one is to be an octave lower than the second.]

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5. Fifty-six tuning forks are arranged in order of increasing frequencies so that each fork

gives 4 beats per second with the next one. The last fork gives the octave of the first. Find the frequency of the first.

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6. A fork of unknown frequency gives 4 beats per second when sounded with another of frequency 256. The fork is now loaded with a piece of wax and again 4 beats per second are heard. Calculate the frequency of the unknown fork.

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7. Calculate the velocity of sound in a gas in which two waves of wavelength $50cm$ and $50.5cm$ produce 6 beats per second.

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8. The prongs of a tuning fork A originally in unison with a fork B os frequency 312 are filed and the forks produce 5 beats per second

when sounded together. What is the pitch of A after filing?

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9. Two tuning forks A and B when sounded together produce 2 beats per second. A has a frequncy of 340. It is now loaded and again sounded with B. It is found that the number of beats is 4 per second. Can you say decidedly what is the frequency of B from this observation?

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10. Two tuning forks when sounded together produce 4 beats per second. The first produces 8 beats per second. Calculate the frequency of the other.

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11. A wave of frequency $500Hz$ has a phase velocity of $350m/s$. (a) How far apart are two points 60° out of phase? (b) What is the

phase difference between two displacement at a certain point at times $10^{-3}s$ apart?

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12. A sensitive microphone with its receiving surface turned towards a long vertical wall is placed at a distance of 2 m from the wall. A strong source of sound of $500Hz$ is placed between the wall and microphone on the line perpendicular to the wall and passing through the position of microphone. Find the position

of the source where no sound will be heard in the microphone. (Velocity of sound in air $= 350ms^{-1}$)

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13. A hollow cylinder of length $1m$ is divided by a thin flexible by a thin flexible diaphragm at a distance one-third the length of the cylinder. It is closed by two other flexible diaphragms at the ends. Of the two chambers into which it is divided, the longer one contains hydrogen and

the other oxygen. The two end diaphragms are set into vibrations of the same frequency. what are the frequencies of the end diaphragms for which the middle diaphragm will be motionless? Velocity of sound in hydrogen $= 1100ms^{-1}$ and that in oxygen $= 300ms^{-1}$.

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14. Sound waves from a tuning fork A reach a point P by two separate paths ABP and ACP.

When ACP is greater than ABP by 11.5 cm, there is silence at P. When the difference is 23 cm the sound becomes loudest at P and when 34.5 cm there is silence again and so on. Calculate the minimum frequency of the fork if the velocity of sound is taken to be $331.2 m / s$.

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15. The following equations represent transvers waves : $z_1 = A\cos(ky - \omega t)$. Identify the combination (s) of the waves

which will produce (i) standing waves (s), (ii) a wave travelling in the direction making an angle of 45° with the positive x and positive y-axes. In each case find the positions at which the resultant intensity is always zero.

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16. Three sound waves of frequencies $320, 344$ and 280 are produced simultaneously. Find the number of beats per second, assuming the human ear's resolution is 10 beats per second.

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17. An echo repeats 5 syllables, each of which requires ⅕th of a second to pronounce and ½ second elapses between the time the last syllable is heard and the first syllable is echoed. Is echoed. Calculated the distance of the reflecting surface, the velocity of sound being $332 m / s$.

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18. A plane wave $\zeta = A\cos(\omega t - kx)$ propagates in the reference frame S. find the equation of this wave in a refreence frame S' moving in the +ve direction of x-axis with a constant velocity V relative to S.

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19. Which of the following represents (a) a progressive wave and (b) a stationary wave?

(a) $y = 2\cos 5x \sin 9t$, $(b) y = 2\sqrt{x - vt}$,

(c) $y = 3\sin(5x - 0.5t) + 4\cos(5x - 0.5t)$

(d) $y = \cos x \sin t + \cos 2x . \sin 2t.$ If progressive, find its velocity.

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20. The shape of a wave is represented by $y = \frac{1}{1+x^2}$ at $t = 0$ and $y = \frac{1}{1+(x-1)^2}$ at $t = 2s$. Assume that the shape of the wave remains unaltered as it advances in the medium. Find the velocity of the wave and represent the wave graphically.

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